the bitstream lead to fractured images where only part of the picture is updated. For a moving sequence this tends to tear apart the image.

Inter-coded data can be used for fast forward play in certain circumstances. For example, if an MPEG sequence with a fixed size GOP has an I or P frame every third frame, a three times speed-up can be extracted by displaying only these frames. The P-frames can be decoded, even though they are inter-coded, because they rely on I-frames or other P-frames which are also in the trick play data stream. This method works only for fast forward as the P-frame motion vectors are only predicted in the forward direction. The use of intra only data works equally well for fast forward and for fast reverse. Again, the data rate for the complete I and P frames will exceed the output data rate of the VTR and the access data rate of the trick play track. A viewable picture can be obtained for each frame display time as long as some lower resolution I frame data and all P frame motion vectors are sent. It is even better if the P frame DC coefficient is also sent, in particular for the case where a macroblock in a P frame is intra coded.

It is desirable for the trick play VTR to extract the data for trick play from the transmitted bitstream, rather than requiring an alternate stream be sent to enable trick play, such as a D-frame sequence. This removes a need for excess transmission bandwidth allocated for redundant trick play data. Extraction of the trick play data can be aided by the encoder through the priority breakpoint in the bitstream, similar to the implementation of frequency scalability. MPEG variable length codewords are assigned priority levels based on their utility for trick play. If a priority breakpoint is set after the subset which defines the trick play data set, the VTR can extract those codewords of the appropriate priority level without decoding the bitstream. This trick play priority stream can also be decoded by a standard MPEG decoder.

If the video is delivered in a packetized format, the trick play priority codewords could be grouped together into packets identified by their priority level. Thus the extraction process becomes a packet switching operation.

If several priority break points were used, the VTR could make a decision based on it's available storage capacity how much trick play data to save by saving one or many priority levels. Thus the trick play track quality could be optimized at record time for the trick play tracks desired.

Below is a list of MPEG data in order of priority for trick play operation:

1. Video codeword headers that contain sequence and picture information for I & P frames, slice headers for I & P frames which contain the position on the screen of slice data

2. Macroblock headers of I & P frames which contain information about either: a macroblock's position within the slice, quantization, the method of coding the macroblocks

3. I frame DC coefficients

4. Motion vectors for P frames , which provide enough information to predict a frame from the last I frame or P frame

5. DC coefficients of the DCT for P frames which correct the predicted frame and improve image quality

6. Some of the higher order DCT coefficients for I frames which can be used to improve the quality of both the I frame and the predicted frame

7. A percentage of the higher order DCT coefficients for P frames which can be used to further improve the predicted frame quality

8. All other data in the video codeword data stream

From this list of priority levels it is clear that an intra-only DC trick play track could be extracted by inserting a priority break point after codewords of level 3. An I and P trick play track, as discussed above for the 3x case, could be extracted by inserting a breakpoint after codewords of priority 4, and after level 5 for superior quality.

CONCLUSION

A method has been described for trick play on a consumer VTR which records digital video compressed to be compatible with MPEG standard. This method introduced the trick play track, which is a section of the tape dedicated for use at a single playback speed and direction faster than record speed. The proposed VTR records the compressed digital MPEG bitstream and plays back to a video decoder. The recorder extracts a subset of the compressed bitstream which may be played back and decoded as a valid trick play image sequence. The extraction is performed on a standard MPEG bitstream without decoding, by use of priority breakpoints and priority marking of packet headers. Good quality trick play can be implemented without changing the MPEG syntax.

Analysis of VTR hardware capabilities formed the basis for determining bounds on trick play data rates. Simulation of trick play sequences was used to optimize trick play data selection for image quality.